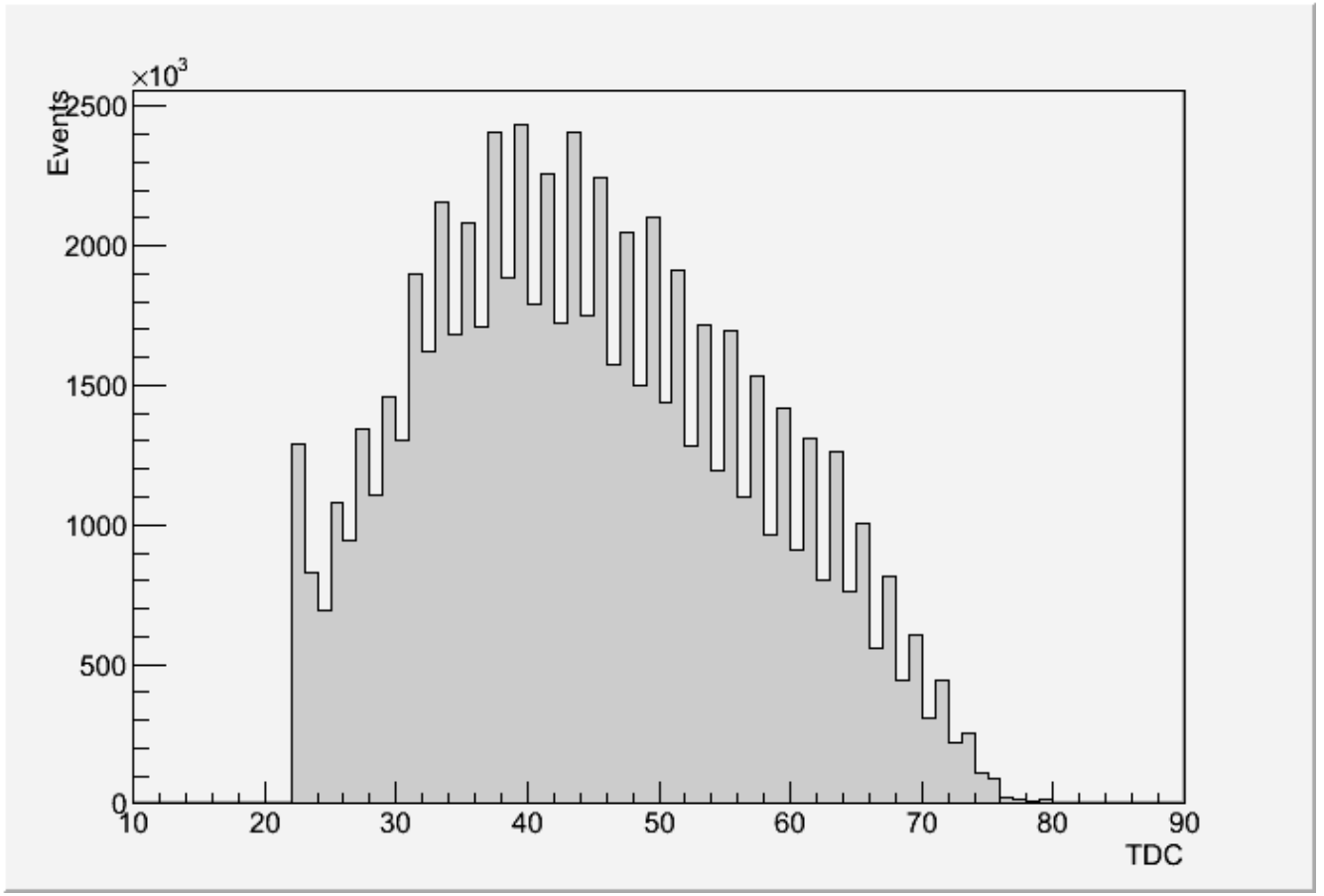
Tdc inhomogeneity & correction

- Tdc inhomogeneity: example in pC data
- Characterization & correction with α run data
- Application: corrected Tdc distributions from pC data
- Outlook: correct dN/dt distributions, t_0 ...

Tdc inhomogeneity

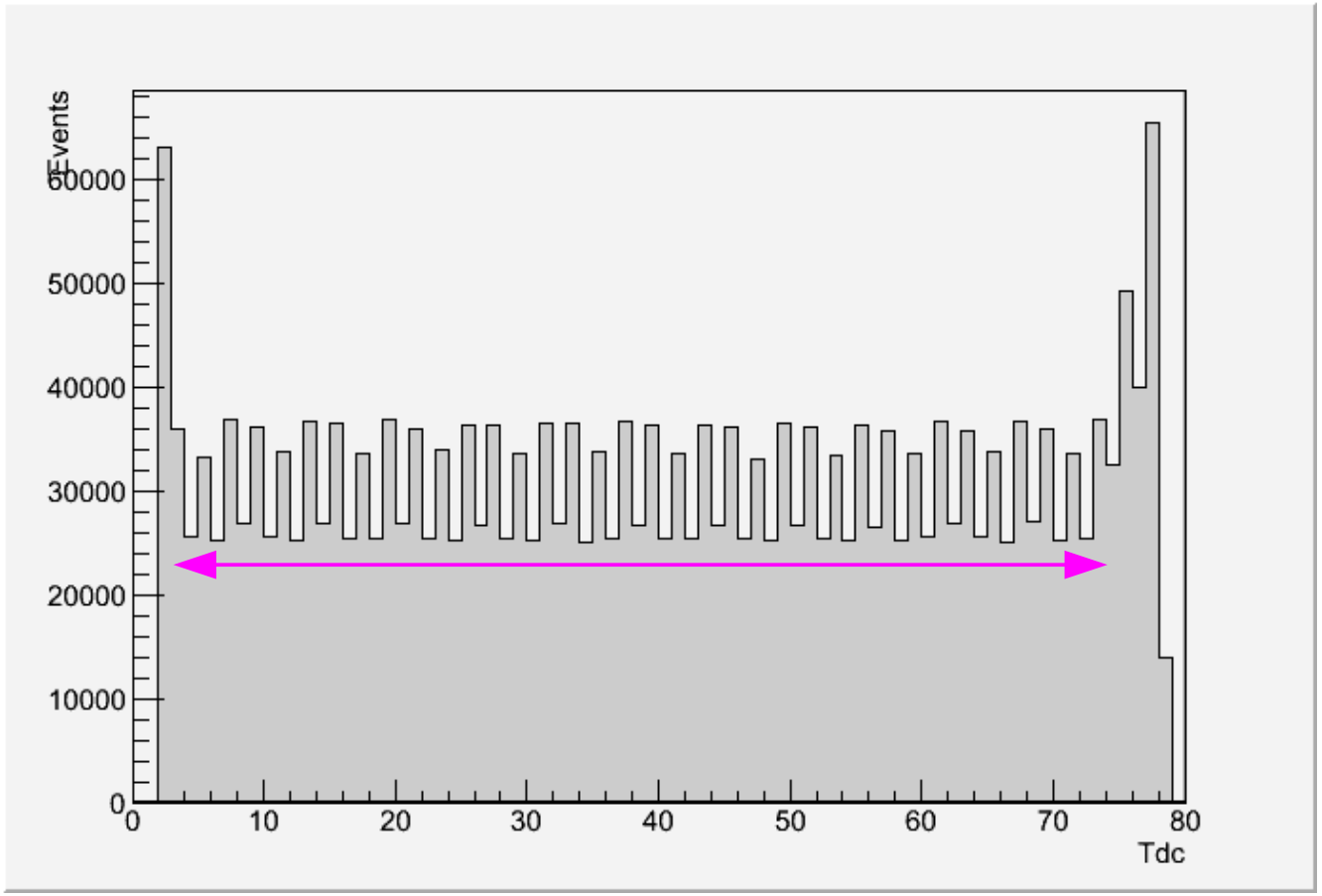
- Tdc distribution from a pC sweep run (sum all chan.):



- Huge systematic inhomogeneity in time reconstruction
- Need to correct if ever want to use maximum 1.2 nS Tdc resolution

α Tdc distribution

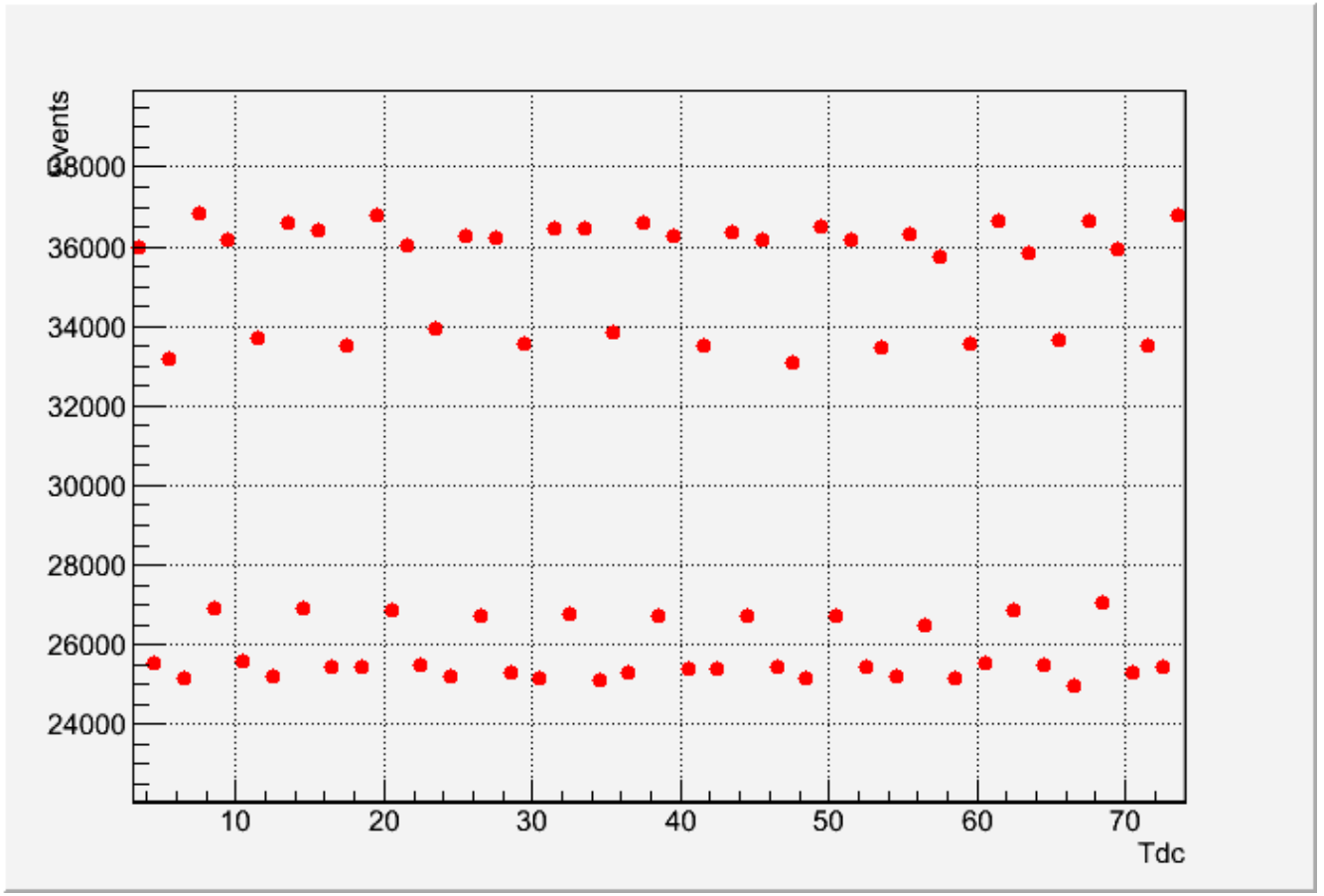
- We know α's are distributed uniformly in time
- α Tdc distribution directly related to time reconstruction inhomogeneity
- Here sum all Run12 α runs, all chan. in Y1D:



- Ignore edge effects Tdc≤3, Tdc≥75
- Clear repetitive pattern, zoom in... ↘

α Tdc distribution zoom

- Pattern ~repeats every 6 Tdc units:



- The alternating hi/low points due to “constant fraction discriminator” wrong pulse shape in algorithm...
- The triplets of hi or low points due to 3 ADCs in WFD, different gains...
- Pattern ~same for other polarims., different WFDs:

⇒ universal WFD property

Tdc correction procedure

α Tdc distribution (histogram) has info about Tdc bins:

- α's distributed uniformly in time $\Rightarrow$

  # events in bin $\propto$ time width of bin
- Bin centers also shift slightly due to varying widths

Correct *any* raw Tdc distribution to differential distribution dN/dt just by manipulating its histogram:

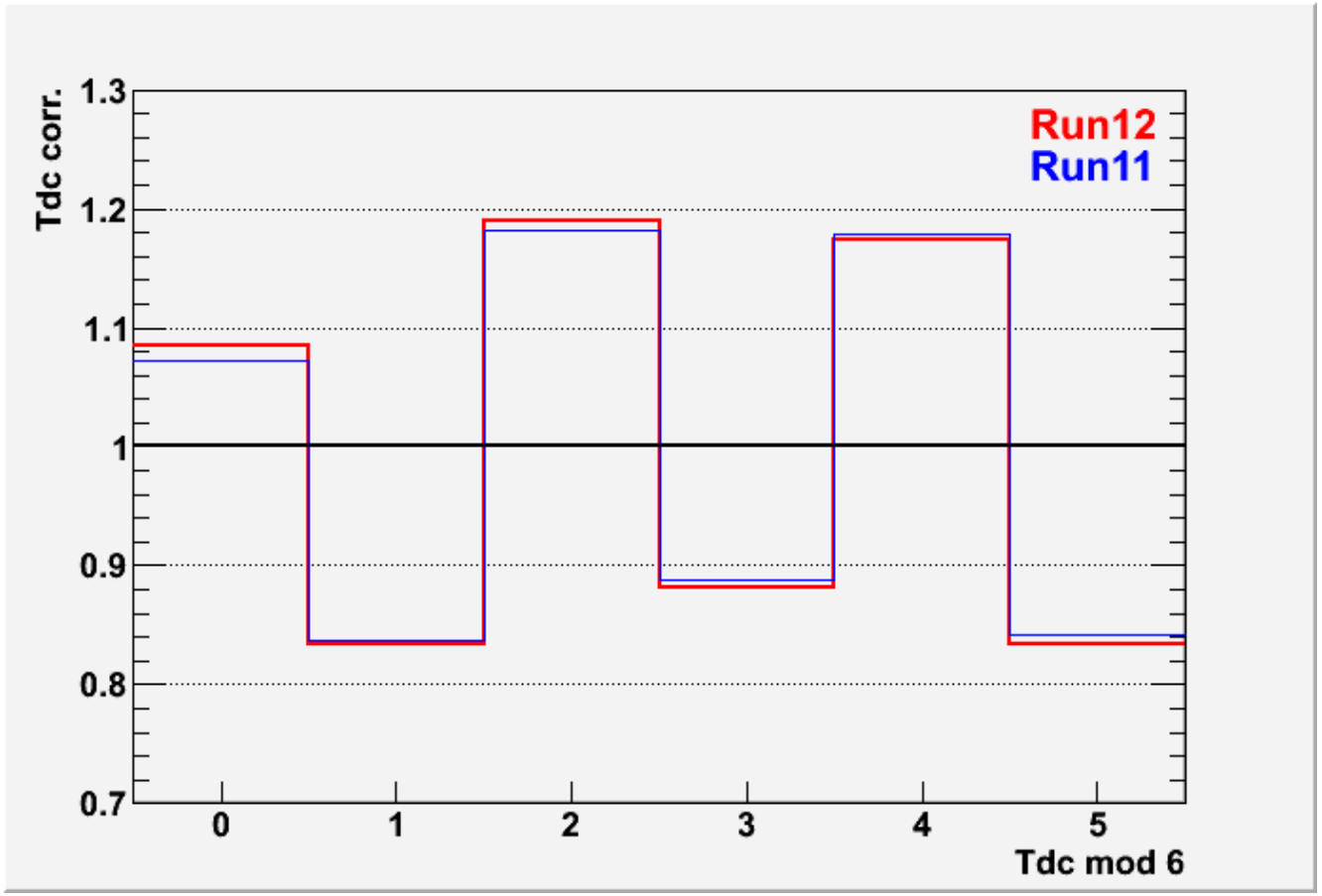
- Divide #events by bin's time width
- Adjust bin centers

Correction factors from α distributions:

- Only need 6 correction factors (bin widths): mod(Tdc,6)
- Bin center adjustments cancel every 6 bins

Tdc correction factors

- From Tdc distribution summed over all Run12 α runs, all channels, all polarimeters:



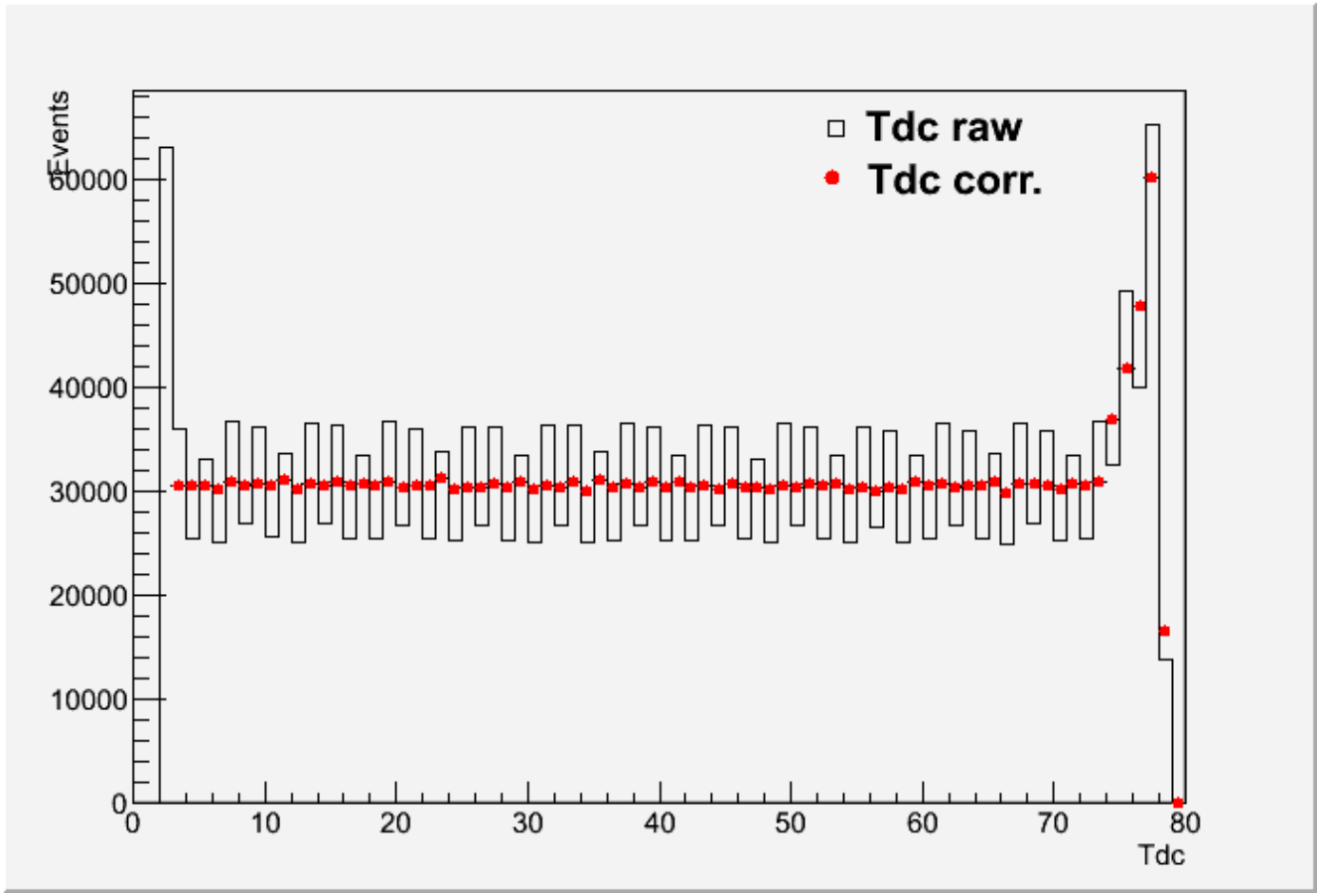
sum corr. factors = 6

- Corrections up to nearly 20%
- Similar analysis I did ~year ago for Run11 α runs ~same factors

$\Rightarrow$ stable property of WFDs

Result: α runs

- Apply correction to sum all Run12 α runs, all chan., all polarim.:



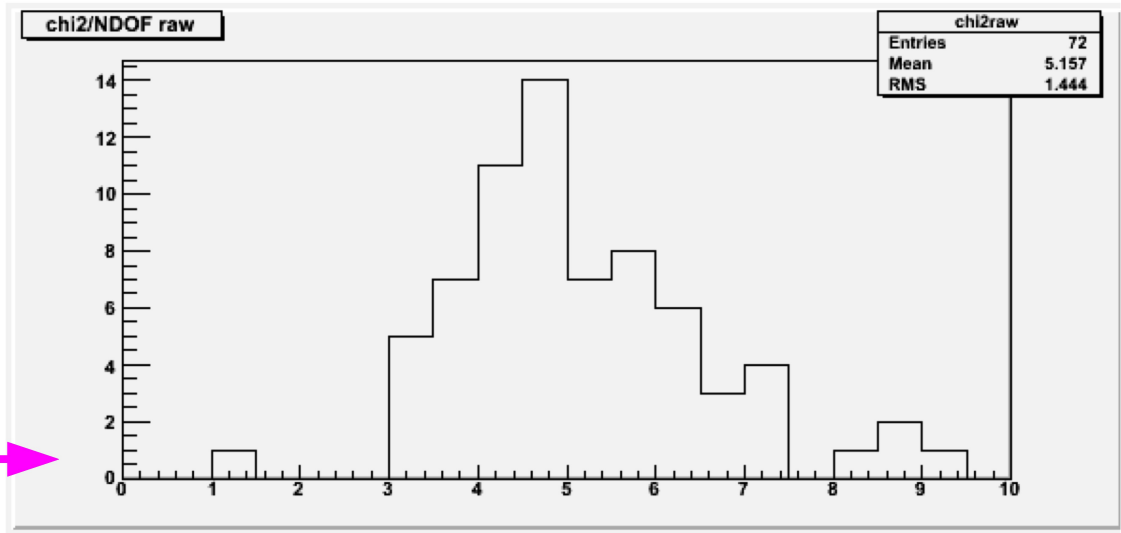
- By construction, corrected dN/dt ~flat
- This was all chan. summed; same factors for individual channels? ↘

Result: α runs per channel

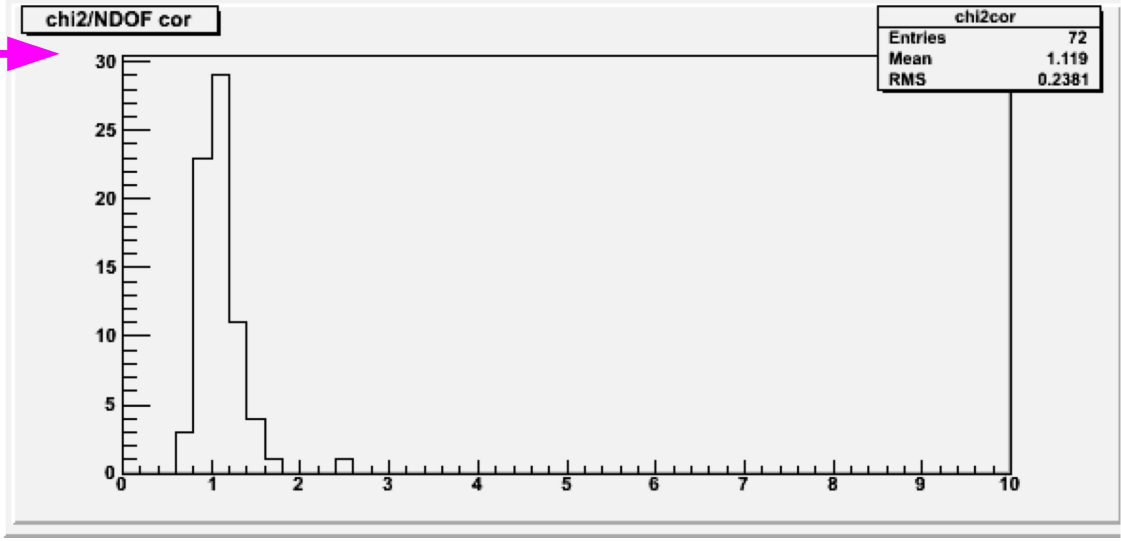
For Blu1, summed over all Run12 α runs, *but for each chan.*:

- Apply same correction factors
- For each chan., do P0 (constant) fit to raw, corr. Tdc distributions
- Compare χ^2/NDOF of fits

raw Tdc:



corrected Tdc:

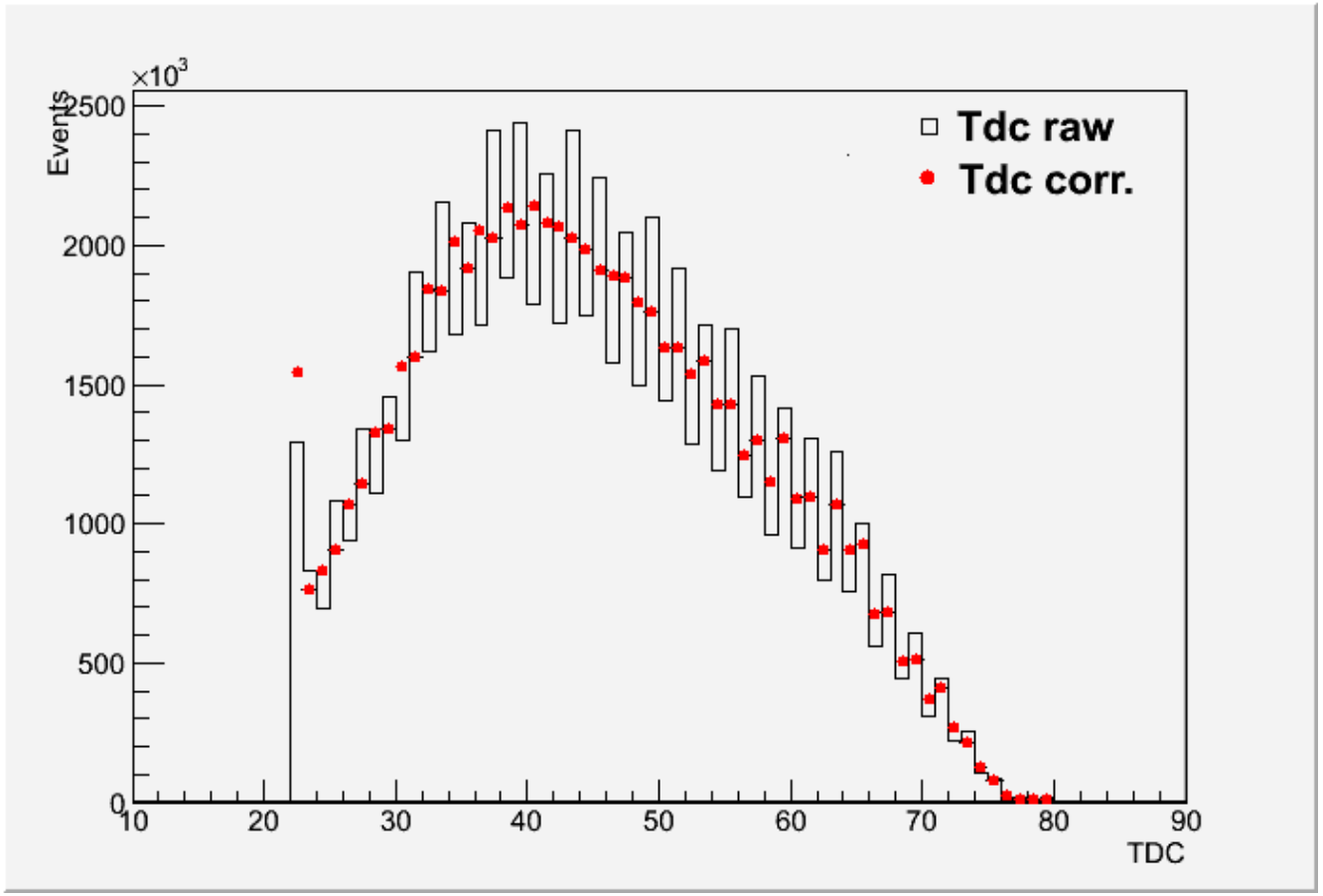


- From raw → corrected χ^2/NDOF 5 → 1

⇒ Same correction factors effective for all channels

Results: pC sweep data

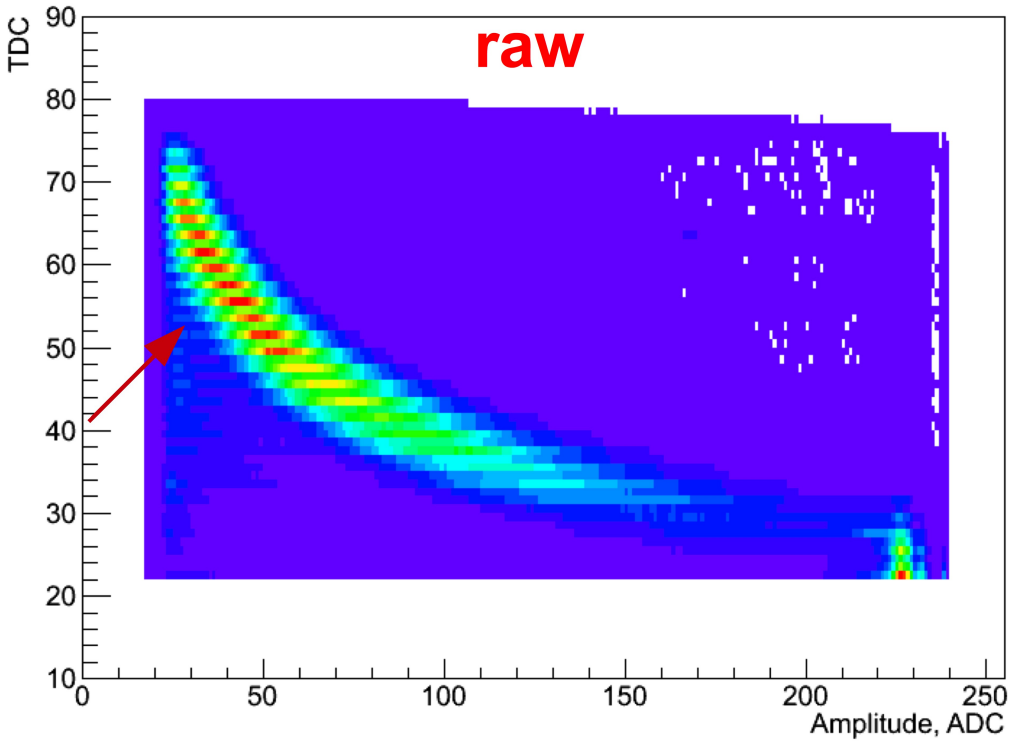
- Correct same raw Tdc distribution shown earlier:

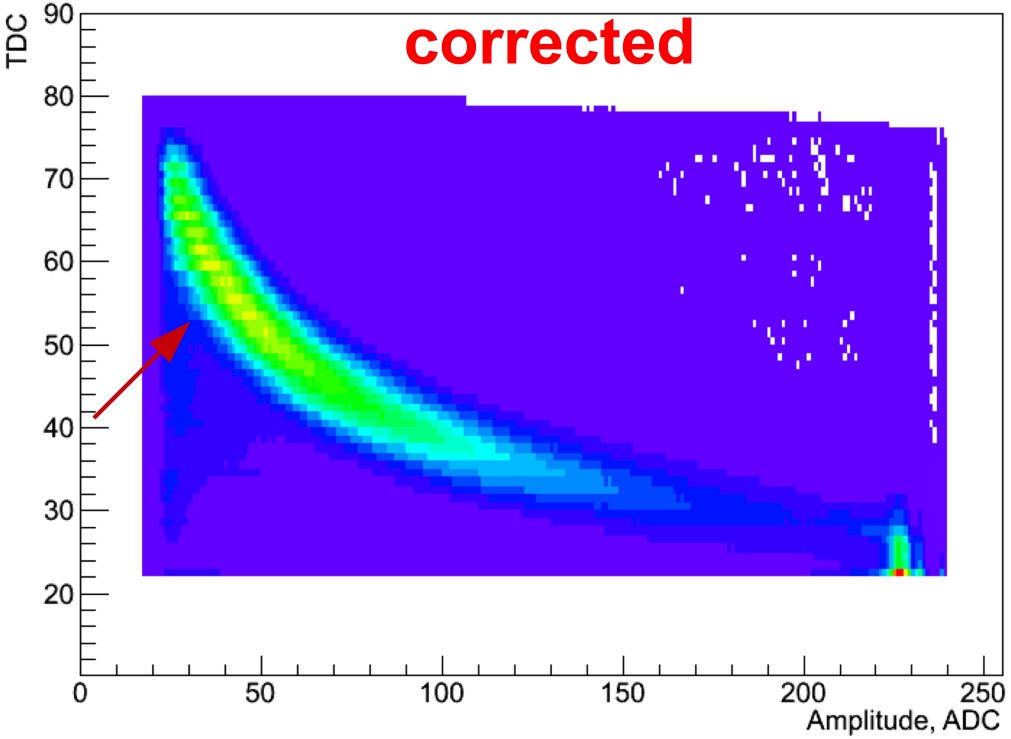


- Now a much smoother dN/dt distribution
- Still some systematic variations, especially @ high Tdc

Results: bananas

- Can also apply correction to Tdc axis of 2d distributions, e.g. bananas:





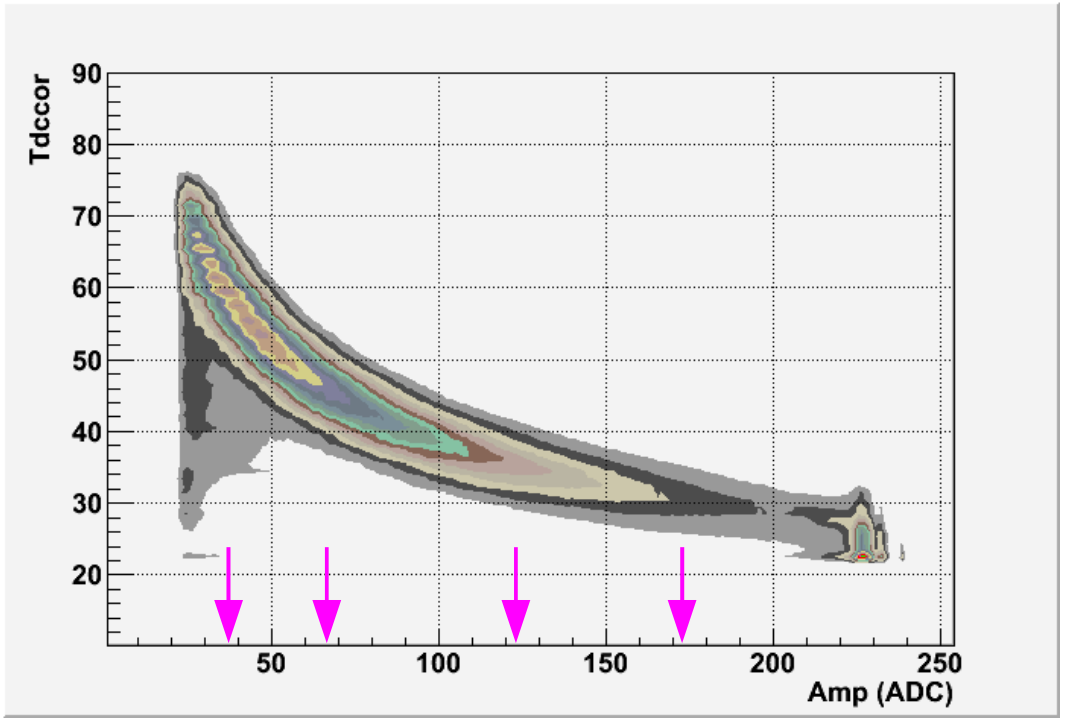
- 'Lumpiness' in Tdc is much reduced

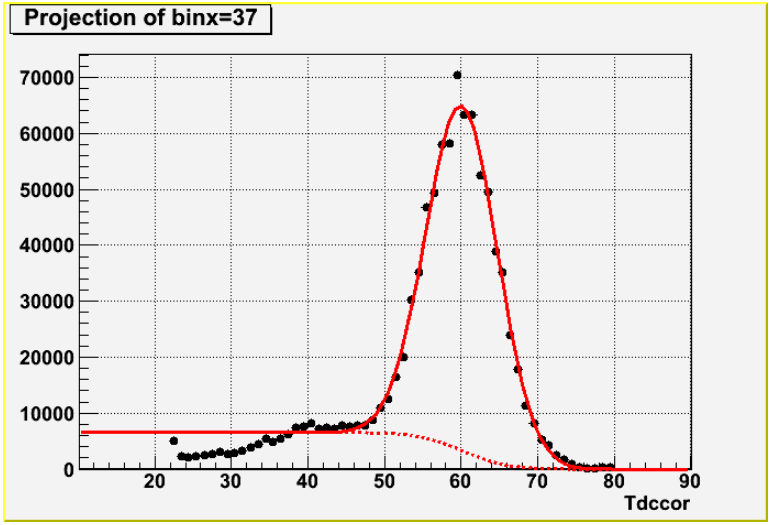
NEXT:

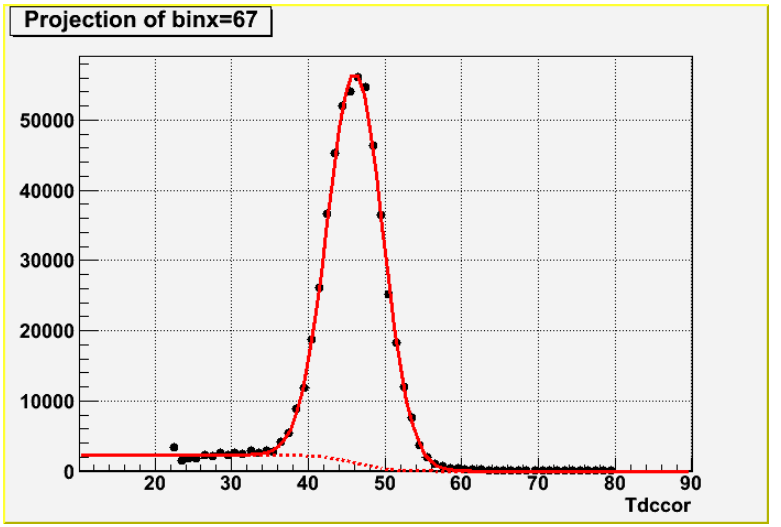
- This was not all a meaningless academic exercise (at least no more so than everything else we do is a meaningless academic exercise)

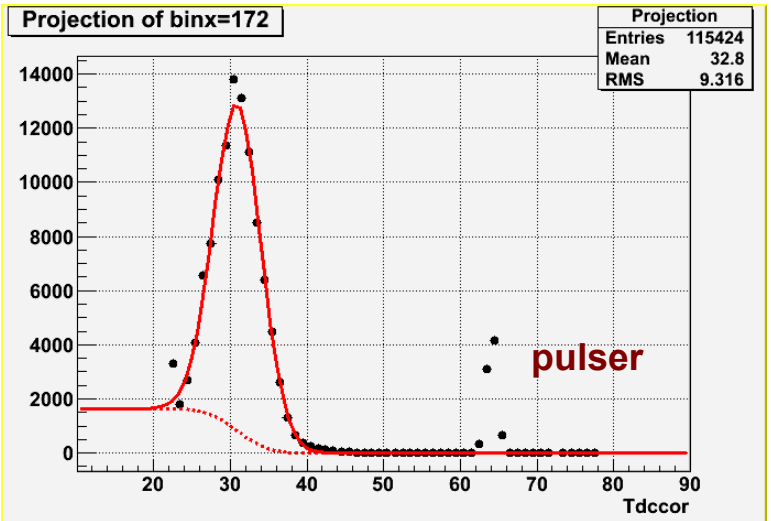
Tdc correction: next

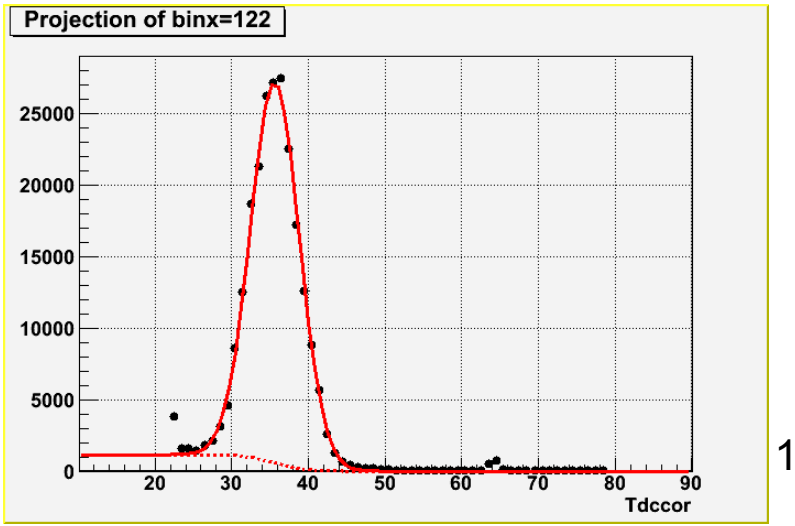
- Can make nice Tdccor slices at fixed Amp and get good fits to smooth functions:





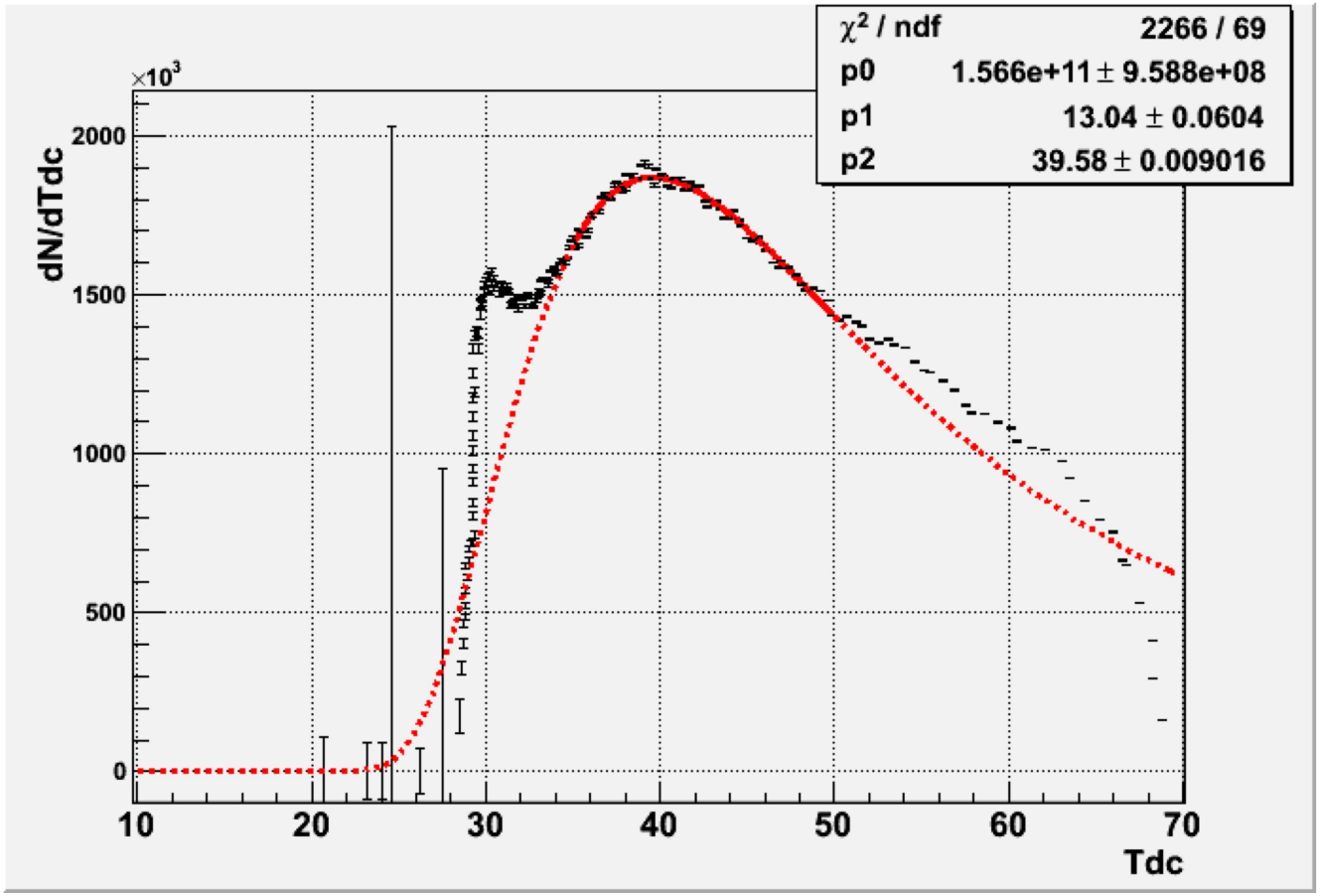






Tdc correction: next

- Use results of Tdccor fits in Amp slices ⇒ real dN/dt distributions:



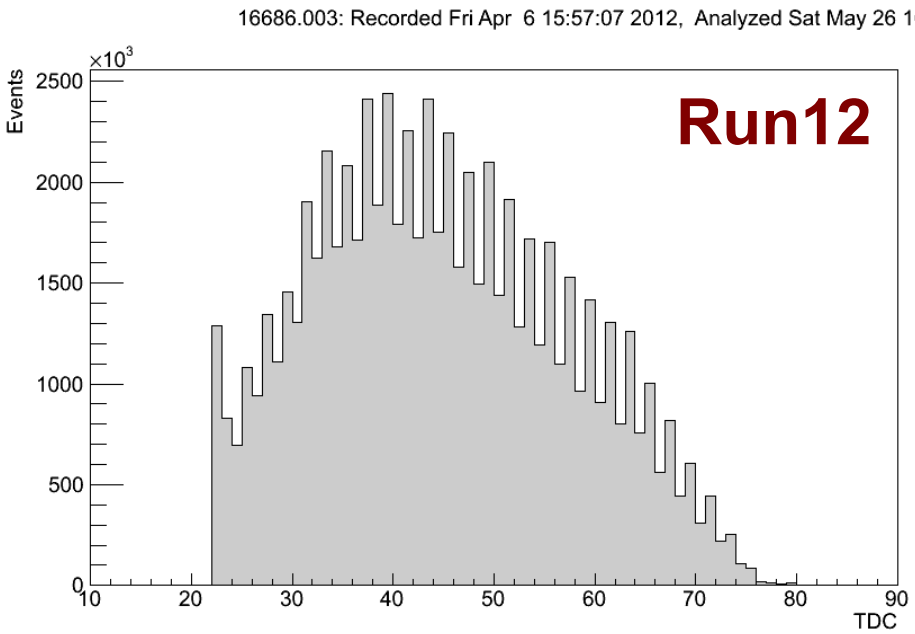
Ultimate goal:

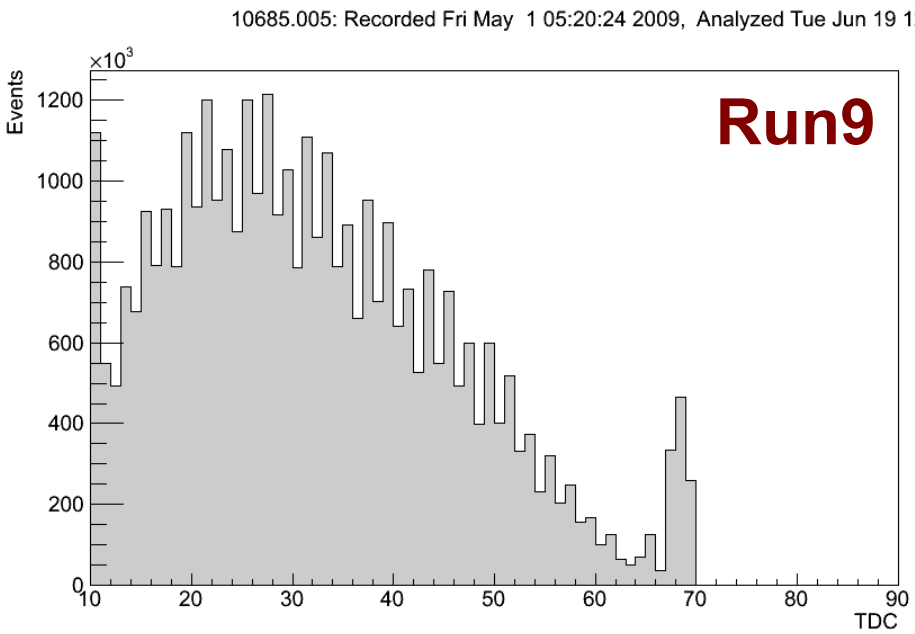
- With real dN/dt distributions extract a $\mathbf{t_0}$ using only timing info

  completely independent of details of C-Si energy response, energy calibration, dead layer & related dogma...

Extras

Pulse shape ⇒ Tdc inhomogeneity?





- No, the inhomogeneity was always there
- Apparently CFD algorithm never tuned for our pulses...